Managing and harnessing soil flora/fauna biodiversity for sustainable crop production in the semi-arid tropics

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The Green Revolution initially resulted in high-yielding cereal varieties responsive to increased inputs that addressed the food needs of several countries, particularly those in Asia. However, after three decades, farmers have started experiencing difficulty in maintaining such high yields, even with increasing levels of inputs. Second-generation issues, fall-outs of the Green Revolution, have now surfaced. These issues include problems associated with soil quality, sustainability, and environmental degradation. Prior to the Green Revolution sustenance agriculture was relatively free from such problems, but it operated at a low level of productivity, that could not sustain the food needs of Asia's ever-growing population.

Several long-term experiments, with such treatments as sole organic inputs in the form of large quantities of farmyard manure (FYM), only occasionally produced higher yields than treatments with chemical fertilizers. Farmers who depend mainly on biological inputs and have a high level of biodiversity on their farms generally claim to produce equal or higher yields than those of farmers in mainstream agriculture. It seems possible to achieve high yields by applying large quantities of FYM/biomass, but except for a few niches, such large quantities of organic materials are not available. At present, farmers in some areas of four Asian countries continue to burn large quantities of crop residues that could be used on their fields, but for other areas strategies for on-farm production of biomass such as growing multiple-use tree species on farm boundaries will need to be considered.

The potential of using environmentally friendly, traditional, and scientific knowledge on soil biology/biodiversity to sustain high crop yields using natural/recyclable resources produced on-farm has been assessed. A 3-year study at ICRISAT revealed that plots receiving large quantities (101 ha^{-1} crop residues and 1.7-2.0 t ha^{-1} compost/FYM annually) of biomass as a surface mulch without tillage yielded more in two out of three years than those receiving recommended tillage, chemical fertilizers, and pesticide applications. The high yields in the biomass-applied plots were largely due to their being least damaged by insect pests. These plots were protected by microbial pesticides developed at ICRISAT, and had high populations of the natural enemies of insect pests, such as spiders and coccinelids.

Although the overall yields were high in the plots receiving biomass, stover yields (above-ground total dry matter minus economic yield) were generally higher (particularly of non-legume crops) in the plots that received both chemical fertilizers and pesticides. Based on this experience and on the available knowledge on soil flora/fauna biodiversity, two protocols (one each for rainfed and irrigated areas) of crop production have been proposed for on-farm evaluation.

Improving agricultural productivity and livelihoods through pollination: some issues and challenges

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With the ongoing shift in the focus of agriculture from subsistence systems to commercial agriculture in many developing countries, new challenges for improving and maintaining productivity are emerging. Among these challenges are crop failures due to inadequate pollination. Like soil, water, and nutrients, pollination is also a limiting factor in crop productivity, in which it plays a crucial role. Figure 1 illustrates the contributions of pollination to enhancing agricultural productivity and improving rural livelihoods. Even if agronomic inputs including: better-quality seed and planting material, good irrigation, use of organic and inorganic fertilizers and biocides are provided, without pollination no fruit or seed will be formed. Pollination failure can be caused by several factors, the most important of which is the lack of adequate numbers of pollinators. In recent years pollinator populations and diversity have been declining, because wilderness and habitats are being lost, land uses are changing, monocultures increasingly dominate agriculture, and excessive and indiscriminate use of agricultural chemicals and pesticides are increasing. Consequently, the need to ensure pollination by conserving pollinators and managing crop pollination has increased and will increase further. Increasing the number of pollinators has become more urgent. This can be achieved by: conserving populations of natural insect pollinators, promoting ecofriendly integrated pest management, and by judicious use of chemical fertilizers and pesticides. But the most practical and preferred solution would be to promote manageable species of honeybees. Such promotion calls for a more intensive focus on the issue from the perspectives of policy, research, development, and extension.